Journal of Resources Development and Management - An Open Access International Journal
Vol.1 2013

Assessment of Selected Physico Chemical Properties of Soil for Site Suitability for Waste Disposal in Abakaliki, Southeast, Nigeria

*Okolo, C.C[1]., Nwite, J.N[1] ., Ezeaku, P.I[2] ., Eze, N.C[2]., Ezeudo, V.C[2] and Akamigbo, F.O.R[2]
1.Department of Soil Science and Environmental Management, Ebonyi State University, P.M.B 053, Abakaliki, Ebonyi State.
2.Department of Soil Science, University of Nigeria Nsukka, Nigeria.
*E-mail of Corresponding authour: okolochukwuebuka@gmail.com

Abstract
An assessment of the physicochemical properties of soil for site waste disposal was carried out in Abakaliki urban, southeastern Nigeria. Three sites namely: Waterworks road (WR), Hill top (HT) and Azuiyiokwu (AZ) were randomly selected. Soil samples were collected from 0-15 cm and 15-30 cm depths from the sites. The soil samples were analyzed for physicochemical properties. The results showed variations in soil properties of the three sites which indicate suitability of the different sites or otherwise for waste disposal. The relationship between percent sand moisture content on dry mass basis and total porosity was generally highly significant (P>0.01). Similarly, the relationship between percent sand and saturated hydraulic conductivity was also highly significant. Available P highly correlated with total porosity and saturated hydraulic conductivity. The sites with high sand percentage are good for refuse disposal while the ones with high clay percentage have problems of water logging and build up of pollution for ground water. Dumpsites Water works road (WR) and Hilltop (HT) are better for waste disposal than dumpsite Azuiyiokwu (AZ).
Keywords: Dumpsites**,** physicochemical, refuse, soil.

INTRODUCTION

Production of waste materials is inevitable consequences of human activities. The United States Environmental Protection Act (USEPA,1990) defined waste as any substance which constitutes a scrap material or unwanted surplus substance which requires to be disposed of. Oyideran (1997) noted that wastes are substances or objects discarded as worthless or unwanted defective or of no further value for manufacturing or production process. Oyideran (1997) classified wastes as follows; mining and mineral wastes, industrial wastes, agricultural wastes, domestic and miscellaneous waste. Waste creation by mankind is inevitable and the worry by environmentalists is the quantity and toxic level posed by the wastes produced.

Waste disposal sites are found in many corners of every state including Abakaliki town. The sites for waste disposal should have good characteristics that do not allow for flooding, pollution of soil and ground water. One of the ways to achieve this is to have impact assessment of proposed sites to determine their suitability. Certain soil properties are used as indicators that enhance a site for disposal. The choice of these refuse dumpsites are sometimes objectively determined with properties that reduce leachates from wastes and pollution of soil and water resources and also reduce the potential health hazard to plant, animal and people (Botkin and Keller, 1998). This necessitates the study of the suitability of physicochemical properties of the soils of dumpsites which influence amounts of leachates, soil and ground water pollution. Consequently there is need to characterize soil used as dumpsite and to monitor the pollution status of major dumpsites in Nigeria from time to time to provide statistical data that inform government decision in policy making, regulation and enforcement. This will reduce the problem of leachates polluting the soil and water and the risks of ectoxicology. This study was therefore carried out to assess selected physicochemical properties of soil for site suitability for waste disposal in Abakaliki.

MATERIALS AND METHODS

Study area

The experiment was carried out in Abakaliki, Ebonyi State. Abakaliki is located at latitude $0^{0}6\ 45^{/}$N and longitude $08^{0}\ 30^{/}$E in the derived savannah agroecological zone of southeastern Nigeria. The area experiences bimodal pattern of rainfall with the first peak occurring between April-July and the second between September and early November and with short spell in August, normally called " *August break*". The area has an average annual rainfall range of 1700-20000 mm and mean annual temperature ranging from 27^{0}C-31^{0} C. The soil belongs to the order Ultisol (FDALR, 1985).

Field studies

Three sites were selected after a reconnaissance survey of the area. The selected sites were expanses of waste land in the Abakaliki urban. Three refuse dumps in Abakaliki urban were identified and selected for study. The refuse dumps were located along waterworks road (WR) beside Deeper Life Bible Church, refuse dumpsite at Hilltop (HT) before SSS headquarters and refuse dumpsite at Azuiyiokwu (AZ), behind Azuiyiokwu Girls'

Secondary School. Soil samples were collected from these dumpsites with soil auger from surface (0-20 cm) and sub-surface (20-40 cm). core samples were collected from 0 – 10 cm soil depth.

Laboratory methods

Core samples were used to determine soil physical properties such as bulk density and hydraulic conductivity, thus total porosity was calculated. The soil auger samples were air dried and sieved using 2 mm mesh sieve. Thereafter, the samples were used to determine particle size distribution of the soils and the chemical properties such as available phosphorus, organic matter and pH

Particle size distribution was determined using hydrometer method according to the procedure of Gee and Or (2002). Bulk density was measured by core method (Grossman and Keinch,2002). Gravimetric moisture content was determined using the method described by Obi (2000). Hydraulic conductivity was determined by Core method of Reynolds (1993). Percentage organic carbon was determined by Wakley and Black method as described by Nelson and Sommers (1982). Available phosphorus was measured by the Bray II method (Bray and Kurtz, 1945).

Data analyses

Data were analyzed using standard deviation. Correlation analysis was used to determine relationship between some soil properties according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

The result of the particle size distribution of the dumpsites shows that the textures of soil were predominantly sandy clay loam (Table 1). The sand fraction was generally higher compared with the other fractions. Percent silt and clay fractions increased with depth in all the dumpsites. High percentage of sand on the topsoil is of advantage as it would encourage seepage. However, sandy loam texture was recommended (Loughry 1973) as being suitable for waste disposal sites, excessive sand fraction (>70%) is highly unsuitable for waste disposal, since they are highly permeable.

Similarly, clay and silt concentration greater than 31% was identified by Bonarius (1975) as unsuitable for waste disposal as they encourage surface flooding and pollution. Excessive drainage of sandy soil can encourage leaching of major cations and anions to the deeper layers. This will increase the possibility of ground water pollution. Nevertheless, Brady and Weil (1999) observed that sandy soils of the humid tropics were unsuitable for waste disposal as they encourage surface flooding and pollution. Furthermore, Brady and Weil (1999) observed that sandy soils of the humid tropics were susceptible to nitrate leaching which promotes eutrophication.

The values of soil bulk density, total porosity and hydraulic conductivity varied with depths and across the three sites (Table 2). Bulk densities were lower (1.28 Mgm^{-3}, 1.43 Mgm^{-3} and 1.53 Mgm^{-3}) in the topsoil and increased (1.33 Mgm^{-3}, 1.70 Mgm^{-3} and 1.55 Mgm^{-3}) in 15-30cm depths in the three sites WR, HT and AZ respectively. Total porosity followed the same trend as bulk density. Following the values, AZ dumpsite would have the problem of flooding and pollution. Whereas moisture content was lower in topsoil at the 0-20cm depth, Ksat followed reverse trend. This was observed in all the depths. The result of Ksat and total porosity concurred in line with the findings of Scharade and Gaviand (1967) who stated that doses of refuse matter applied to the soil increased total pore volume of the soil and favours the penetration of water disposal as they had values from 0.15 - 0.22. Thus moisture contents within the range of 0.51 to 3 were suitable for waste disposal (Bonarius 1975).

Chemically, organic matter was generally higher in 0-20 cm soil depth of the studied sites and decreased with depths (Table 3). Azuiyiokwu (AZ) dumpsite had the highest value (22.11%) followed by Water works road (WR) dumpsite (16.515%) and the least value of 15.30% obtained in Hilltop (HT) dumpsite. Available phosphorus was higher in Water works road (WR) dumpsite and low in the other ones and with the depths. However, available phosphorus was higher in subsurface soil depth of Hilltop (HT) dumpsite. This result showed that organic matter content was higher on top soils, suggesting higher chelating activities of some waste products including phosphates. The result showed also that phosphorus had lower values as it has been used up in the chelation activities. Ekundayo and Fagbani (1996) reported that a high level of organic matter was found to be conducive for heavy metal chelation, increased exchange capacities and infiltration of surface water.

In terms of relationships of the soil properties, the result showed that the soil properties had positive but highly significant ($P<0.01$) relationships. This shows that these soil properties influenced suitability of the sites for waste disposal. Table 4 indicates that proportion of particle size distribution to a certain degree could dictate the behaviours of some soil physicochemical properties and hence can have a great influence on suitability of soil for waste disposal.

CONCLUSION

Results from this study showed that soil properties influence choice of soil for site waste disposal. Properties that discourage flooding and seepage or pollution are good indicators for choice of sites for waste disposal. Planned dumping of wastes would help to reduce problems of soil and ground water pollution as well as environmental degradation. Thus, dumpsites Water works road (WR) and Hilltop (HT) are better for waste disposal than dumpsite Azuiyiokwu (AZ).

REFERENCES

Bonarius, H.M (1975). Suitability guide for Rating Soils for Waste Disposal. German Agency for Technical Co-operation, West German, Pp 68.

Botkin, D.B and Keller, E.A (1998). Environmental Science, 2nd ed.,John Wiley and Sons. Canada

Brady, N.C and Weil, R.R (1999). *The Nature and properties of soils. 12th ed.,*Prentice Hall Upper Saddle River, New Jersey.

Bray, R.H and Kurtz, L.T (1945). Determination of total organic carbon and available forms of phosphorus in *soil sci.* j. 59:39-43.

Ekundayo, E.O and Fagbemi, A.A (1996). Landuse Land Cover and its Association with Soils of Oyo State in Southern Nigeria. *Int J.Trop. Agric.,* 14:21-33.

Federal Department of Agricultural land Resource (FDALR, 1985). Reconnaissance Soil Survey of Anambra State of Nigeria. Soil Reports 1985 (FDALR) Lagos, Nigeria.

Gee, G.W and Or, D (2002). Particle size Analysis, In: Methods of Soil Analysis, Dane, J.H. and G.C Topp (Eds), Part 4, Physical methods. Soil Sci. Am. Book Series No.5.

Grossman, R.B and Riensah, T.G. (2002). Bulk density and linear extensibility, In: Dane, J. A and Topp. G.C (Eds). Methods of Soil Analysis Part 4: Physical Methods. Soil Sci Am Book Series No.5, ASA and SSA, Madison, WL P. 202 -228.

Loughry, F.G (1968). The Use of Soil Science in Sanitary Landfill Selection and Management. *Geoderma* 10:131-139.

Machi, I.A (2007). Urban Solid waste Problem in Nigeria. Department of Geography, University of Nigeria, Nsukka.

Nelson, D.W. and L.E. Sommers. (1982). Total carbon, organic carbon and organic matter. In: Page, A.L., R.H. Miller and D.R. Kenney (eds.) Methods of Soil Analysis, Part 2.
America Society of Agronomy, W.I. Madison, pp: 539-579.

Obi, M.E (2000). Soil Physics. A Compendium of lectures. University of Nigeria Nsukka, Nigeria P. 103.

Oyideran, A.B.O (1997). Waste Generating and Disposal in Nigeria. A Keynote address in: Okali, D. *et al.,* (Eds). Perspective in Environmental Management, Proceedings in NEST workshop 1991 to 1995. NEST Ibadan Pp. 95-100.

Reynolds, W.D (1993). Saturation Hydraulic Conductivity Laboratory Measurement, In Soil Sampling Analysis. Carter, M.R. (ed) Lewis Publishers, Boca Raton pp 589-590.

Scharade, A and Galliand, F (1967). Effects of Organic Fertilizer from City Trash on Phosphorous Assinilation. *Technol* 69.17-26.

Steel, R.G. and Torie, J.H (1980). Principles and Procedures of Statistics. A Biometrical Approach. Second ed. MsGrow. Hill, New York.

USEPA (1990). Integrated Risk Information System (IRIS). National Centre for Environmental Assessment, Office of Research and Development, Washington, DC.

Table 1: Particle size distribution at the different sites.

Dumpsite	Depth cm	%clay	%silt	% sand	Texture
WR	0-15	22	21	55	sandy clay loam
	15-30	30	23	47	sandy clay loam
HT	0-15	22	13	65	sandy clay loam
	15-30	30	25	45	clay loam
AZ	0-15	30	20	50	clay loam
	15-30	35	23	42	clay loam

WR = Water works road, HT = Hilltop, AZ = Azuiyiokwu .

Table 2. Variations in soil properties within depths at the different sites.

Soil Depth	Soil Properties	WR	HT	AZ
0-15cm	BD(mgm-^{3})	1.28	1.43	1.53
	TP(%)	51	42	47.5
	Ksat (cm^{-1})	39.9	40.44	34.38
	MC (%)	0.18	0.15	0.16
	SD	26.22	21.20	23.76
15-30cm	BD(mgm^{-3})	1.33	1.70	1.55
	TP(%)	49	34	38
	Ksat (cm^{-1})	31.35	19.2	28.32
	MC (%)	0.22	0.16	0.17
	SD	23.85	19.28	19.07

BD= Bulk Density (cm^{-3}),MC= Moisture content %,TP= Total porosity (%),
SD= Standard deviation, Ksat= Saturated hydraulic conductivity, WR = Water works road, HT = Hilltop, AZ = Azuiyiokwu .

Table 3: Variations in available phosphorus and percent organic matter within depths at the different sites.

Soil depth	Soil properties	WR	HT	AZ
0-15 cm	Av P(mgkg^{-1})	14.92	7.46	2.80
	OM (%)	16.51	15.30	22.11
	SD	6.84	32.10	8.92
15-30cm	Av P(mgkg^{-1})	14.92	13.06	2.80
	OM (%)	1.79	2.06	11.00
	SD	7.30	7.48	5.82

Av P = Available phosphorus , OM= Organic matter, WR = Water works road, HT = Hilltop, AZ = Azuiyiokwu .

Table 4: Correlation coefficients between selected soil properties

Soil Properties	Correlation coefficient (r)
Sand vs MC	0.98^{xx}
Clay vs OM	0.97^{xx}
Sand vs TP	0.97^{xx}
Av P Vs TP	0.90^{xx}
Sand Vs Ksat	0.93^{xx}
OM Vs Ksat	0.90^{xx}

TP= Porosity — OM= Organic matter
Vs= versus — Ksat= Saturated hydraulic conductivity
MC= Gravimetric moisture content — ^{xx} significant at P = 0.01
Av P= Available Phosphorus